Unit A Conclusion

A key theme in Unit A has been the idea of keeping healthy. This unit has examined how your health can be affected by both lifestyle choices and the genes that you inherit. In the first part of the unit you examined how the circulatory and immune systems work together to keep you healthy. You studied the major components of these two systems and considered factors that can affect how they function. A better understanding of these two body systems will help you make healthy choices. In the second chapter of Unit A you looked at the major principles of genetics, and you used these concepts to explain how some traits and diseases can appear more often in some families.

Throughout the unit you investigated and evaluated technologies used to explore, maintain, repair, and assist our bodies. Genetic discoveries and—in particular—the use of genetic technologies can be controversial, and you evaluated their use and made decisions about the extent they should or could be used.

The theme of maintaining health will still be relevant in upcoming units as you study the health effects of radiation and of chemicals released into the environment.

Career Profile

Research Scientist—Pulmonary Medicine

Malcolm King's father was the first person on his reserve to graduate from university. His example made Malcolm seriously consider following in his dad's footsteps to become a high school teacher. Malcolm took that dream down a different path; and today, he teaches pulmonary medicine at the University of Alberta in Edmonton.

Malcolm is not only a professor, but a prominent research scientist. His main area of interest is mucus rheology—the study of the flow of mucus in lungs and other organs. His research focuses on developing treatments for diseases that affect the ability of people to breathe, such as asthma, bronchitis, and cystic fibrosis. Two of the treatments he has developed for chronic lung disease have been patented. Malcolm admits that the patents are two of his greatest scientific accomplishments so far.

Malcolm's passion for science began as a young man. He recalls, "Mr. E.R.S. Hall, my high school chemistry teacher, made chemistry interesting, especially [the] lab experiments." After high school, at age 17, Malcolm moved to Hamilton to attend McMaster University, where he obtained a Bachelor of Science degree in chemistry. He then moved to Montreal, where he obtained a PhD in Polymer Chemistry from McGill University in 1973.

Malcolm knows that school can be tough. For him, the hardest part was "setting priorities for work and study." But he got through it by staying focused on his long-term goals. As someone who knows, he encourages students to "stick with it—there are some really interesting opportunities ahead for Native people." According to Malcolm, "education is an integral part of economic well-being. We need to understand how the economy works if we are to control our destiny."

As the project leader for the University of Alberta's Aboriginal Health Training Initiative, Malcolm aims at increasing the number of Aboriginal students in medicine, dentistry, and related professions. He believes that "you don't have to give up your Native identity when you take up science and engineering. "In fact, it can only help with the well-being of your community."

Unit A Review Questions

1. Match each of the following definitions relating to heart structures to its correct term.

- pulmonary artery
- vena cava
- pulmonary vein
- ventricle
- septum
- atrium
- heart valve
- aorta

a. one of the heart's upper chambers that receives blood returning to the heart

b. one of the heart's lower chambers that pumps blood from the heart

c. a thick wall of muscle that divides the left and right sides of the heart

d. a thin flap of tissue inside the heart that regulates the direction of blood flow within the heart by preventing the backflow of blood

e. the large vein that collects oxygen-poor and carbon dioxide-rich blood from the upper (superior) body and lower (inferior) body

f. the vessel that carries blood away from the heart and toward the lungs

g. the vessel through which oxygen-rich blood flows toward the heart

h. the body's largest artery

2. Record the following table in your notebook. Leave enough room for your responses. Sketch a cross section of the three main types of blood vessels to indicate the relative differences in size and structure between these three types of vessels. Below each sketch, indicate the role of that vessel in the circulatory system.

Artery	Vein	Capillary
Sketch	**Sketch**	**Sketch**
Role	**Role**	**Role**

3. Match each blood component listed on the left with its correct function.

- red blood cell
- white blood cell
- platelet
- sample of plasma

a. a cell that defends the body against disease

b. a yellowish liquid like the broth of a soup made up mostly of water with substances dissolved or floating in it

c. a blood cell that contains hemoglobin and transports oxygen from the lungs to the body's cells

d. a very tiny cell fragment that helps seal skin cuts by initiating clot formation

4. State similarities and differences between the following three disorders of the circulatory system—angina, a heart attack, and a stroke.

5. The different types of white blood cells each have a specific role that can be compared to the role of people and objects associated with a hockey game. Complete the following table by matching each type of white blood cell to a person or object from a hockey game.

a. macrophage
b. memory B- and T-cells
c. B-cells
d. helper T-cells
e. suppressor T-cells
f. antigen

Person or Object and Role	Type of White Blood Cell
Coach—co-ordinates and directs team's moves and analyzes other team's plays	
Offensive players—try to keep opposing team's players and puck on opposition side	
Coach's playbook—keeps records of strategies used to win games	
Referee—calls an end to game	
Jersey—makes a distinction between players	
Defensive players—respond to opposing players who have broken through their defensive line	

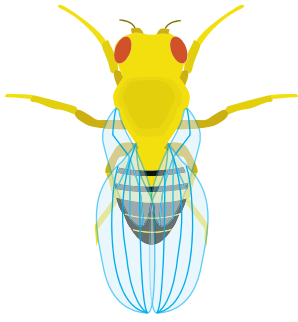
6. Match each term relating to the structure of genetic material with its corresponding definition.

- DNA base triplet
- chromosome
- gene
- karyotype
- amino acid
- protein
- gamete
- DNA

a. all chromosomes from one nucleus matched into their respective pairs and arranged from the largest pair to the smallest pair
b. a sex cell, such as a sperm or an egg, produced during meiosis
c. a molecule that forms a twisted-ladder shape
d. a segment of a DNA molecule that carries information resulting in the production of a specific protein
e. one of 20 possible building blocks used to form proteins as determined by the sequence of bases along a DNA molecule
f. the condensed form of all DNA visible when cells are viewed with a microscope
g. a molecule made from a chain of amino acids that serves a variety of functions in the body including transport, communication, and regulation
h. three adjacent nitrogen bases found along a DNA molecule that code for an amino acid to be produced or begin or end the reading of a gene

7. *Drosophila melanogaster* is a commonly studied species of fruit fly having normal-sized wings. *Drosophila* is dominant over a fruit fly having much smaller wings, called vestigial wings. Use the symbol *W* to represent the allele for normal-sized wings and the symbol *w* to represent the allele for vestigial wings.

a. Write the possible genotypes for a fruit fly with wings of a normal size.
b. Write the genotype for a fruit fly with vestigial wings.
c. Write the possible genotype of the gametes for a fruit fly that is heterozygous for the wing-size trait.
d. State the phenotype of a fruit fly with the *ww* genotype.



8. Describe how the listed components of DNA combine to form a DNA molecule.

deoxyribose sugars
phosphate groups
four nitrogen bases

9. Identify the key characteristics in the following genetic diseases.
   a. an autosomal dominant disease
   b. an autosomal recessive disease
   c. a sex-linked disease
10. List the basic steps involved in producing and using a DNA fingerprint to positively identify biological evidence left at a crime scene.

Use the following information to answer question 11.

A baby will occasionally be born with a hole in the septum between the right and left ventricles. This causes the flow of blood through the heart to be disrupted. Septal defects result in a large amount of blood bypassing the lungs as it leaks through the septum. This impairs the efficient delivery of oxygenated blood to the body. A small hole in a baby's septum usually closes up on its own, but larger holes require surgery to be sealed. Babies born with this defect are often referred to as *blue babies* because they have a bluish tinge to their skin.

11. Explain why the skin of a baby with a septal defect might seem bluer than the usual pinkish-red coloured skin of a newborn baby.

Use the following information to help you answer question 12.

Blood types are determined by the presence of antigens on the surface of a red blood cell. One type of antigen is called the Rhesus factor or Rh factor. The production of the Rh antigen is determined by a single gene with two different alleles. The Rh positive (or Rh^+) allele produces the antigen and the Rh negative (or Rh^-) allele does not produce the antigen. The Rh^+ allele is dominant over the Rh^- allele.

12. a. Draw a Punnett square for a cross between a male with the genotype Rh^+/Rh^- and a female with the genotype Rh^-/Rh^-.
    b. State the percentage probability—as a percentage or a ratio—that the offspring will have the *Rh* positive blood type.
    c. State the percentage probability that the offspring will have the *Rh* negative blood type.
    d. State the percentage probability that the offspring will have the *Rh* positive blood type but carry the *Rh* negative blood type allele.
    e. Individuals with the *Rh* negative phenotype produce an immune response to the presence of blood cells possessing the *Rh* antigen. Describe the action of the immune system if someone with the *Rh* negative phenotype is given a transfusion of blood containing cells that are *Rh* positive.

13. A patient has a blood sample taken. Describe the possible symptoms a patient will likely experience given each of the following blood test results.

Blood Test Results	Possible Symptoms
a low red blood cell count	
a high white blood cell count	
a very low T-cell count	
a low platelet count	

14. Scientists are using genetic engineering to develop pigs that incorporate human genes. The pigs can then produce human antigens. The purpose of this technology is to make organs from the genetically engineered pigs usable for transplantation into humans.

a. Explain, in general terms, how the process of genetic engineering can be used to place human genes into pigs.

b. List one risk and one benefit of using genetic engineering to produce these modified pigs.

15. Cyclosporin is a drug that suppresses the immune system. It is given to recipients of organ transplants. Cyclosporin acts to reduce the number of white blood cells—particularly the killer T-cells—thereby reducing the number of white blood cells able to attack the transplanted organ. In many cases, recipients have to take immune-suppressant drugs for the rest of their lives to avoid rejecting the new organ.

a. Identify a negative effect that might result from taking an immune-suppressant drug like cyclosporin.

b. Explain why a person who receives an organ transplant from an identical twin would have much less of a chance of having the organ rejected.

16. A karyotype of an individual is completed by using samples of the individual's blood. State what a karyotype distinguishes, and explain its uses.

17. A gardener crossed a white-flowered tulip with a red-flowered tulip. He then collected the seeds from the offspring of this cross and later planted them. The offspring from this cross all grew red flowers.

a. Identify which of the two colours is dominant.

b. State the genotype for offspring of the cross of two parents.

c. When Carter, a gardener allowed the second-generation tulips to self-fertilize, he found that the seeds produced both red tulip and white tulip plants. When Carter counted and compared the differently coloured plants, he found that there were about three red tulips for every single white tulip. Explain the proportion of each colour observed in the most recent generation of plants.

18. Examine the three different point mutations that have occurred in copies of the same DNA sequence. Identify the mutation with the greatest effect on the amino acid chain produced relative to the original strand.

Original DNA sequence: AGGGCGCCGTTATAT

Mutated DNA sequence # 1: CGGGCGCCGTTATAT

Mutated DNA sequence # 2: AGGGCGCCGTAATAT

Mutated DNA sequence # 3: AGGGCGCCGTTATAC

Use the following information to answer question 19.

Tsarina Alexandra of Russia carried the recessive form of the gene causing hemophilia, which is found on the *X* chromosome. Tsar Nicholas II did not have hemophilia.

19. a. Construct a Punnett square to demonstrate the cross of alleles possessed by the Russian Monarch Tsar Nicholas II and his wife, Tsarina Alexandra.

b. State the probability of a male offspring from this cross developing hemophilia.

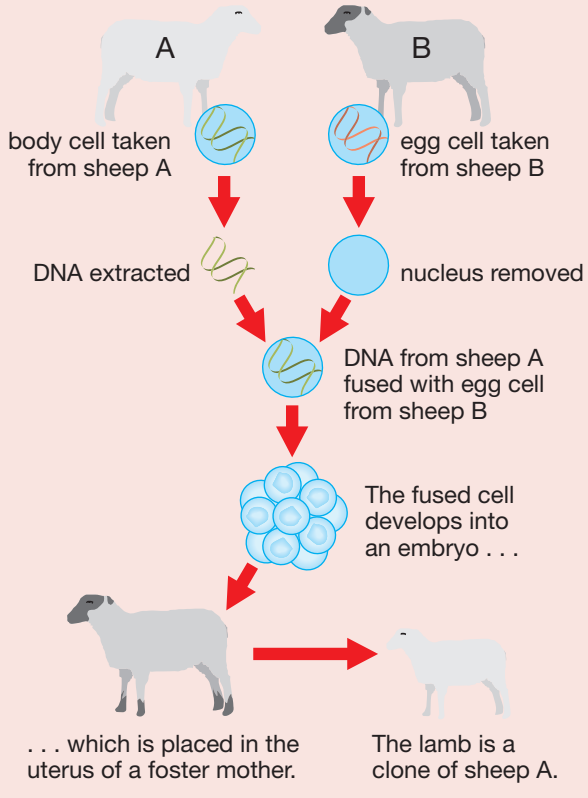
c. Nicholas and Alexandra's only son, Alexei, developed hemophilia, but his four older sisters did not have hemophilia. Explain how it is possible that none of his sisters developed hemophilia.

d. The famous historical figure named Rasputin gained influence with the Russian royal family because he claimed that he could heal Alexei's hemophilia. Use your knowledge of the circulatory system and genetics to explain why it could not have been possible for Rasputin to cure Alexei of hemophilia.

e. The Tsar and his family were assassinated as part of the Russian Revolution of 1917. Years later, a woman appeared and claimed to be Anastasia, one of the daughters of Nicholas and Alexandra. Throughout her life, this woman maintained that she was Anastasia. A DNA sample from a piece of her intestine was removed during an operation and preserved. This sample was compared to DNA from the royal family members, whose bodies were uncovered in 1998. This DNA comparison was used to prove that she was not Anastasia. How can DNA be used to identify members of the same family?

20. Use the following information to answer questions 20.a. to 20.f.

During the process used to create the clone of a sheep, scientists took an egg cell from one sheep and removed its chromosomes. An autosomal cell from a second adult sheep was isolated and placed next to the egg cell. Electricity was used to fuse the two cells together, and they began to divide into a zygote, which was genetically identical to the adult sheep's autosomal cell. The clone zygote was implanted into a third sheep's uterus, where it developed into a baby sheep.



a. Would the egg cell be described as haploid (1n) or diploid (2n) before its chromosomes were removed?

b. Would the autosomal cell from the adult sheep be described as haploid (1n) or diploid (2n)?

c. Would the clone zygote produced from the two fused cells be described as haploid (1n) or diploid (2n)?

d. Explain why the chromosomes needed to be removed from the egg cell to create the clone zygote.

e. Compare and contrast the process of cloning with the process of fertilization.

f. Even though the cloned sheep and the sheep from which the autosomal cell was taken share all the same genes, they may differ slightly. Explain how slight differences such as adult size and behaviour are possible.